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Complications of Standard Elective Abdominal Aortic Aneurysm Repair

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Objective: *To evaluate complications of standard elective repair of infrarenal abdominal aortic aneurysms.*
Design: *Prospective multicentre study.*
Materials: *Two-hundred and ninety-one consecutive patients undergoing standard elective surgery for an infrarenal aortic aneurysm.*
Methods: *Recording adverse events according to the recommendations of the Ad Hoc Committee on Reporting Standards.*
Results: *Seventy-five patients (26%) experienced some complication following elective aortic aneurysm surgery. Twenty-two patients had a mild complication (7.6%, 95% C.I. 4.8–11.2%), 27 a moderate (9.3%, 95% C.I. 6.2–13.2%) and 26 patients had a severe and/or fatal complication (8.9%, 95% C.I. 5.9–12.8%). The in-hospital mortality was 4.1% (12 patients, 95% C.I. 2.2–7.1%). Cardiac failure was the commonest primary cause for death (58%). Twenty-two per cent of the patients had a non-fatal complication: the most frequent being pulmonary (10%) and cardiac (10%).*

Patients with a history of cardiac events had a five times higher risk of a fatal outcome (95% C.I. 1.1–24.0) and a two and a half times higher risk of any severe fatal or non-fatal complication (95% C.I. 1.0–6.5). Other risk factors were advancing age and the presence of pulmonary disease.
Conclusions: *In addition to mortality, morbidity figures of standard aneurysm operations are important, as well as associated risk factors. This is especially true when evaluating early repair of small aneurysms and new endovascular techniques.*

Key Words: Morbidity; Complications; Adverse events; Aneurysm; Aortic aneurysm.

Introduction

In a recently published meta-analysis of elective abdominal aortic aneurysm surgery on 17 238 patients, a mortality of 6.8% was found.[1] However, as the meta-analysis included results of semi-elective operations for symptomatic, non-ruptured aneurysms, the true elective mortality figure might be lower. In contrast, the operative mortality figure for ruptured aortic aneurysm is around 50%[2] and the overall mortality is estimated to be over 80%. Elective surgical repair of asymptomatic aneurysms therefore is generally accepted as the preferred method for preventing rupture and associated death. The results of elective aneurysm repair continue to improve, especially in single centre experiences, with reported mortality figures of less than 5%.[3] However, this does not reflect the overall complication rate. Studies on morbidity of standard elective surgery are relatively scarce.[4–9] This is remarkable, considering the debate on the usefulness of screening and early elective repair of small aneurysms (less than 5 cm).[10,11] Moreover, to analyse and compare the effect of less invasive, endovascular techniques, morbidity rates of standard elective surgery are important. Information on complications is also important in preoperative discussions with patients.

In the present prospective multicentre study we particularly addressed complications (morbidity and mortality) and associated risk factors of elective standard surgical treatment for infrarenal abdominal aortic aneurysm, following the recommendations of the Ad Hoc Committee on Reporting Standards.[12,13]

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Patients and Methods

Patients

In the prospective Multicentre Aneurysm Study (MAS) on elective infrarenal aortic aneurysm surgery we aimed at assessing: (i) morbidity and mortality and associated risk factors and; (ii) aneurysm prevalence in male siblings of patients and the psychological effect of screening. The present study is confined to the first part of the MAS-study. Five hospitals participated in this study (three university hospitals and two large district hospitals), four of which may be regarded as referral centres. From 1 May 1993 to 1 May 1995 all consecutive patients admitted for elective infrarenal aneurysm repair were asked to participate in the study. Preoperative evaluation was not standardised as this is not the case in general practice, but was dependent on individual decisions of the surgeon and consulting specialists in internal medicine, cardiology and pulmonology. Inclusion started after acceptance for operation. Those who refused to participate were excluded.

Base-line characteristics

Demographic data and preoperative health status including a history of cardiac events, hypertension, chronic obstructive pulmonary disease (COPD), diabetes mellitus, smoking, cerebral events and renal insufficiency were recorded. A history of cardiac events was defined as prior myocardial infarction (documented with ECG-changes), arrythmias or current or treated angina pectoris. We were not informed about percutaneous transluminal angioplasty or coronary bypass grafting, unless this was specifically mentioned in the medical history. Hypertension was defined as a diastolic blood pressure of ≥ 105 mmHg measured on admission or the use of anti-hypertensive medication. COPD was defined as pulmonary disease associated with chronic outflow obstruction, with exclusion of specific lung diseases (as for example sarcoidosis), and recorded on the patients history and the use of bronchodilators. Diabetes mellitus was recorded in case of insulin dependence or the use of oral anti-diabetic medication. The smoking status was recorded following patients' information on admission. A history of cerebral events comprised a transient ischaemic attack (TIA) or cerebral infarction/bleeding (CVA). Renal insufficiency was recorded only when this required haemodialysis.

Adverse events

Intra- and postoperative morbidity, recorded as complications occurring during that same admission irrespective of the duration of admission, was graded as mild, moderate or severe, following the recommendations of the Ad Hoc Committee on Reporting Standards.[12,13] In addition, fatal complications (following the recommendations entered as severe adverse events) are mentioned separately. Mortality was defined as death occurring within 30 days after surgery (30-day mortality) or during hospital admission irrespective of the duration of hospital stay (inhospital mortality). End-points were both death and the combination of severe complications and death.

Statistical analysis

Morbidity and mortality figures were expressed as proportions with 95% confidence intervals (95% C.I.).

Table 1. Baseline characteristics of the 291 studied patients undergoing elective surgical repair of infrarenal abdominal aortic aneurysm.

	n =	Percentage
Demographic		
Hospitals		
St Antonius, Nieuwegein	116	40
Academic – Utrecht	68	23
Academic – Maastricht	38	13
Westeinde, The Hague	36	12
Academic – Leiden	33	11
Gender		
Men	261	90
Women	30	10
Age		
<60 years	35	12
60–69 years	113	39
70–79 years	119	41
≥80 years	24	8
Aneurysm diameter		
<4 cm	8	3
4–4.9 cm	51	18
≥5 cm	232	80
Health status*		
Cardiac history (total)	146	50
Previous infarction	87	30
Arrythmia	29	10
History angina pectoris	77	26
Hypertension	124	43
COPD	44	15
Diabetes mellitus	20	7
Smoking	126	43
Previous CVA/TIA	26	9
Renal insufficiency	7	2

COPY = chronic obstructive pulmonary diseases; TIA = transient ischaemic attack; CVA = cerebral vascular accident.
* More than one risk factor could be present in one patient.

Table 2. Complications in the 291 studied patients undergoing elective surgery for infrarenal abdominal aortic aneurysm.

Adverse events	Number of patients* A Mild	B Moderate	C Severe	Severity/outcome
Systemic/remote				
Cardiac	1	19	9 (9)	A=no haemodynamic consequence; B=symptomatic/required treatment; C=cardiac arrest/fatal
Cerebral	1	1	1 (1)	A=TIA/temporary deficit; B=permanent deficit; C=fatal
Deep venous thrombosis	0	0	0	A=hospitalisation not prolonged; B=treatment prolonged hospitalisation; C=required operation
Pulmonary	17	12	1 (1)	A=transient, not requiring ventilator; B=required ventilator; C=fatal
Coagulation complications	2	1	6 (2)	A=resolving without treatment; B=requiring drug therapy; C=requiring operation or fatal
Renal insufficiency	6	2	3 (2)	A=transient, not requiring dialysis; B=transient, required dialysis; C=permanent (dialysis, transplant, death)
Local/vascular				
Anastomotic haemorrhage	0	0	2	A=observed; B=required aspiration, drainage; C=required anastomotic repair, revision
Atherothromboembolism	1	2	3	A=without tissue loss; B=minor tissue loss/amputation; C=major tissue loss/amputation
Colon ischaemia	0	1	0	A=not requiring operation; B=colon resection or colostomy; C=fatal
Spinal cord ischaemia	1	0	1	A=transient; B=minor permanent deficit; C=major permanent deficit
Local/non-vascular				
Fascial disruption	0	4	3	A=no treatment required; B=local correction; C=total dehiscence requiring plasty
Ureteral injury	0	0	0	A=resolved spontaneously; B=required drainage, diversion; C=surgical correction or nephrectomy required
Wound infections	2	7	0	A=treated with antibiotic; B=treated with drainage; C=required graft removal or bypass

* More than one complication could be present in one patient.
Values in parentheses are fatal complications.

Associations between risk factors and the end-point mortality and the combined end-point severe complications and mortality were assessed with logistic regression analysis and expressed as odds ratios (ORs) with 95% confidence intervals. Age was entered as a continuous variable whereas other possible risk factors were dichotomised. Multivariate logistic regression was performed to estimate the independent effects of risk factors on both end-points. New factors can also be entered in a logistic regression model and if these "new" factors prove to be statistically significant, a new factor is found.[14] Analyses were performed using the statistical packages SAS and Egret.[15,16] p values ≤ 0.05 were considered statistically significant.

Results

During 24 months 291 consecutive patients were admitted for elective surgical repair of their infrarenal abdominal aortic aneurysm in one of the five participating hospitals. All were included, as none of the patients refused to participate in the study. Most were men (90%). The mean age was 69 years (range 45–87 years). The base-line characteristics of the patients are given in Table 1. The average aneurysm diameter was 5.8 cm (median 5.5 cm, range 3.0–11.0 cm). Of all aneurysms, 20% were less than 5 cm. Half of the patients (50%) had a history of cardiac events and 30% had experienced a prior myocardial infarction. Hypertension was found in 43%.

Seventy-five patients experienced some complication following elective aortic aneurysm repair (26%, 95% C.I. 21–31%). Of these, 49 (17%, 95% C.I. 13–21%) suffered from just one complication, 26 patients (8.9%, 95% C.I. 5.9–12.8%) had more than one complication and nine patients (3.1%, 95% C.I. 1.4–5.8%) had more than two. Three patients eventually developed a multiple organ failure and died. Twenty-two patients had a mild complication (7.6%, 95% C.I. 4.8–11.2%), 27 had moderate complications (9.3%, 95% C.I. 6.2–13.2%) and 26 patients (8.9%, 95% 5.9–12.8%) experienced severe and/or fatal complications. Sixty-three patients had at least one non-fatal complication

Table 3. Crude figures and odds ratios (ORs) of risk factors for mortality and the combined end point severe complications and mortality (95% confidence intervals are within parentheses) each with *p* values.

		Mortality			Severe complications and mortality		
Risk factor	*n*=	*n*=	OR (95% C.I.)	*p* value	*n*=	OR (95% C.I.)	*p* value
Sex							
Men	261	11	0.8 (0.1–6.3)	0.8	23	1.2 (0.3–4.1)	0.8
Women	30	1			3		
Age in years			1.04 (0.96–1.13)		0.5	1.03 (0.97–1.09)	0.5
Cardiac history							
Yes	146	10	5.3 (1.1–24.4)	0.02	18	2.4 (1.01–5.7)	0.04
No	145	2			8		
Previous MI							
Yes	87	7	3.5 (1.1–11.2)	0.03	9	1.3 (0.5–3.0)	0.6
No	203	5			17		
Missing	1	–			–		
Angina pectoris							
Yes	77	5	2.1 (0.6–6.7)	0.2	10	1.8 (0.8–4.3)	0.1
No	214	7			16		
Hypertension							
Yes	124	6	1.3 (0.4–4.3)	0.6	14	1.6 (0.7–3.6)	0.2
No	164	6			12		
Missing	3	–			–		
COPD							
Yes	44	5	4.4 (1.3–14.5)	0.009	7	2.3 (0.9–5.8)	0.08
No	247	7			19		
Diabetes mellitus							
Yes	20	0	–	0.3	0	–	0.1
No	286	12			26		
Missing	3	–			–		
Smoking							
Yes	126	4	0.7 (0.2–2.3)	0.5	8	0.6 (0.3–1.5)	0.3
No	150	7			15		
Missing	15	1			3		
TIA/CVA							
Yes	26	1	0.9 (0.1–7.4)	0.9	1	0.4 (0.1–2.9)	0.3
No	264	11			25		
Missing	1	–			–		
Renal insufficiency							
Yes	7	0	–	0.5	1	1.7 (0.2–14.9)	0.6
No	284	12			25		

MI = myocardial infarction; COPD = chronic obstructive pulmonary diseases; TIA = transient ischaemic attack; CVA = cerebral vascular accident.

(22%, 95% C.I. 17–26%) (Table 2). Most complications recorded were in the group systemic/remote (75%), whereas in 10% the complications were local/vascular. Most frequently recorded were pulmonary (10%) and cardiac (10%) complications. Of 29 severe complications in 26 patients, 15 occurred in patients who died postoperatively. The in-hospital mortality was 4.1% (12 patients, 95% C.I. 2.2–7.1%), 30-day mortality 3.8% (95% C.I. 1.9–6.7%). A cardiac complication was the most frequent primary cause for death (seven patients).

Table 3 shows that previous myocardial infarction was a strong risk factor for the development of adverse events. Advancing age and the presence of COPD were associated with both end-points, although not statistically significant. In multivariate logistical regression these associations slightly increased when adjusted for all other risk factors (Table 4). An odds ratio of 1.05 each year of advancing age means an additional risk for death of 5% for every year of ageing. Only a cardiac history was independently associated with both mortality and with the combined end-point of severe complications and mortality.

Table 4. Adjusted odds ratios of risk factors for mortality and the combined end point severe complications and mortality (95% confidence intervals are within parentheses).

Risk factor	Mortality Odds ratios (95% C.I.)	Severe complications and mortality Odds ratios (95% C.I.)
Age in years	1.05 (0.96–1.15)	1.03 (0.97–1.1)
Cardiac history	5.0 (1.1–24.0)	2.5 (1.0–6.5)
COPD	3.6 (0.96–13.5)	2.1 (0.8–5.8)

COPD = chronic obstructive pulmonary diseases.

Discussion

The main finding in this prospective study on elective aortic aneurysm repair is that only 74% of the patients underwent the entire procedure without any complication. Twenty-two per cent of the patients experienced some non-fatal complication. A history of cardiac events was an important risk factor for the occurrence of operative morbidity and mortality. Advancing age and COPD were additional risk factors both for severe complications and mortality, though not significant. Undoubtedly there is an influence of intraoperative factors, as clamping time and blood-loss, on postoperative morbidity and mortality; however, this was not one of the objectives of the study and was therefore not recorded. Moreover, the aim of this study was to address the postoperative complications of conventional infrarenal aortic aneurysm surgery as is performed in general surgical practice. The inclusion criterium in this study was a patient accepted for and undergoing elective infrarenal aortic aneurysm surgery. The global complication figures resulting from this study therefore are a reflection of general surgical practice without detailed analysis of additional intraoperative risk-factors. However, we studied a selected group of patients as, except for one, all hospitals were referral centres. Therefore, the preoperative general health condition of the patients studied may be worse when compared to the average condition of the average Dutch aortic aneurysm patient. Moreover, it remains unknown how many patients were not referred for elective surgery by their general practitioners, internists, cardiologists and pulmonologists because they were deemed unfit for surgery.

Although the lowest mortality figures are more likely to originate from single centre studies, the (in-hospital) mortality of 4.1% in the present multicentre study is comparable to rates reported in literature. However, this low rate meant that it was only possible to identify risk factors with a relatively large influence on the occurrence of postoperative mortality.

Literature data on morbidity of elective aneurysm surgery are relatively scarce[4–9] and mostly focus on the topic of postoperative mortality figures. In an early report, Diehl *et al.* found postoperative complications in 20% of 350 elective infrarenal aortic aneurysm repairs between 1974 and 1978.[4] Amundsen *et al.* described a prospective multicentre study on 444 consecutive patients with an abdominal aortic aneurysm, of which 279 underwent an elective operation. Postoperative complications, however, were not defined nor graded, and no overall complication figure can be calculated from the figures presented.[5] Johnston *et al.* performed a multicentre prospective study of non-ruptured aortic aneurysms. Postoperative complications, however, are merely mentioned as related to several risk factors and not presented as a specific entity. No overall complication figure is presented and the results can not be compared to the figures of our study.[6] Hallet *et al.* restricted the reporting of complications (30-day) to cardiac events and stroke in a retrospective study of 130 patients undergoing elective aortic aneurysm surgery between 1971–1987.[7] The overall complication figure reported was 11%. Recently White *et al.* compared complications of endoluminal and standard aortic aneurysm treatment.[8] The small control cohort of 27 patients who underwent the standard operative procedure was a selected group of patients also suitable for undergoing endoluminal treatment and, moreover, was studied retrospectively. In that study only 55% of the patients underwent the standard treatment without any complications. Finally, in a large, but retrospective, study by Sayers *et al.* on 671 patients undergoing operative treatment for an abdominal aortic aneurysm, morbidity figures are presented. Unfortunately these are presented only for the whole group of elective and urgent operations for symptomatic and ruptured aneurysms and not specified for elective operations separately.[9] It seems obvious that there is a need for standardised reporting of complications of aneurysm surgery. The present study is to our knowledge the first prospective multicentre study on morbidity of elective surgery for abdominal aortic aneurysm following the recommendations on Reporting Standards.[12,13]

In conclusion, in this multicentre prospective study of elective surgery on infrarenal aortic aneurysms, complications occurred in 26%. Most were systemic (mainly cardiac and pulmonary) complications (75%). In 9% complications were severe or fatal (most cardiac). Important risk factors were a history of cardiac events, pulmonary diseases and advancing age. In the evaluation of the benefit of early elective surgery on small aneurysms, apart from mortality, morbidity has to be taken into account. These complication rates for standard surgical treatment are also important when evaluating new, less invasive endovascular techniques in the treatment of aortic aneurysms.

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